NOVEMBER/DECEMBER 2025

23PPH12 — CLASSICAL MECHANICS AND RELATIVITY

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. State the principle of virtual work in a mechanical system.

2. What are transformation equations in the context of mechanics?

3. Write the equations of motion for a compound pendulum using Lagrangian mechanics.

4. What is D'Alembert's principle?

5. Define phase space.

6. What is the Hamiltonian function?

7. Define stable and unstable equilibrium in a mechanical system.

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Explain in detail the mechanics of a single particle and extend the concept to a system of particles. How do the principles of motion and forces change when moving from a single particle to multiple particles?

17. Derive the Lagrangian equations of motion for conservative systems. Discuss how kinetic and potential energies are incorporated into the Lagrangian formulation and provide examples?

18. Analyze the motion of a particle in a central force field with Hamiltonian mechanics, deriving the equations of motion and discussing the impact of conservation laws, like angular momentum, on the particle's trajectory.

19. Explain theory of linear triatomic molecular.

20. Explain Lorentz transformation equation and its applications.

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8. What are the implications of normal mode frequencies for oscillatory systems?

9. Write Einstein's mass energy relation.

10. Introduce four vectors (position, velocity, momentum, acceleration, force) and their notation.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Define holonomic and non-holonomic constraints. Provide examples to illustrate the differences between them.

Or

(b) Explain the configuration space for a system of particles and its importance in mechanics.

12. (a) Describe the motion of a spherical pendulum using Lagrangian mechanics.

Or

(b) Discuss how Lagrangian equations can be used to describe the motion of a particle on the surface of the Earth.

13. (a) Derive the Hamiltonian for a simple pendulum and explain its physical meaning.

Or

(b) Illustrate the relationship between generalized coordinates and generalized momentum.

14. (a) Explain the process and significance of normal coordinates in oscillatory systems.

Or

(b) Discuss the concept of normal modes in mechanical systems.

15. (a) Explain the concepts of internal and non internal frame of reference.

Or

(b) What is Minkowski space, and why is it crucial for understanding the principles of special relativity?